CLAIMS

What is claimed is:

1. A method for tracking a target in a sequence of measurements, comprising:

modeling the target with a switching linear dynamic system (SLDS) comprising a plurality of dynamic models;

associating each dynamic model with a switching state such that a model is selected when its associated switching state is true;

determining, for a given measurement, and for each possible switching state, a set of continuous state estimates;

determining a state transition record by determining and recording, for a given measurement and for each possible switching state, an optimal previous switching state, based on the measurement sequence, wherein the optimal previous switching state optimizes a transition probability based on the set of continuous state estimates;

fitting a measurement model of the target to the measurement sequence; and

estimating a trajectory responsive to fitting the measurement model, the state transition record and SLDS parameters, said estimated trajectory comprising a sequence of continuous state estimates of the target corresponding to the measurement sequence.

2. The method of Claim 1, wherein the set of continuous state estimates is obtained through Viterbi prediction.

3. The method of Claim 2, wherein the optimal previous switching state is an optimal prior switching state.

4 The method of Claim 3, wherein the transition probability is dependent only upon Markov process probabilities.

5. The method of Claim 2, wherein the optimal previous switching state is an optimal posterior switching state.

6. The method of Claim 1, wherein the set of continuous state estimates is obtained by combining Viterbi predictions with samples drawn at random according to a continuous state sampling density.

7. The method of Claim 6, wherein the optimal previous switching state is an optimal prior switching state.

8. The method of Claim 6, wherein the optimal previous switching state is an optimal posterior switching state.

9. The method of Claim 6, wherein the set of continuous state estimates is obtained by combining a subset of Viterbi predictions with samples drawn at random according to a continuous state sampling density.

10. The method of Claim 6, wherein the continuous state sampling density is given by a Viterbi mixture density.

11. The method of Claim 6, wherein the set of continuous state estimates is updated, responsive to the given measurement, and the optimal previous switching state optimizes a posterior transition probability over the updated set of state estimates.

12. The method of Claim 11, wherein the samples from a continuous state sampling density are updated by a gradient descent procedure.

13. The method of Claim 11, wherein samples from a continuous state sampling density are updated by linearizing around sample positions and applying an Iterated Extended Kalman Filter.

14. The method of Claim 1, wherein the measurement sequence comprises an image sequence, and wherein the transition probability is responsive to the comparison between an image feature model and the given image measurement.

15. The method of Claim 14, wherein the image feature model is a template model.

16. The method of Claim 14, wherein the image feature model is a contour model.

17. The method of Claim 1, wherein the SLDS model models motion of a human figure.

18. The method of Claim 17, wherein the SLDS model is learned from training data of figure motion.

19. The method of Claim 1, wherein the SLDS model models motion of a human face.

20. The method of Claim 19, wherein the SLDS model is learned from training data of facial motion.

21. The method of Claim 1, wherein the SLDS model models the evolution of acoustic features in a speech waveform.

22. The method of Claim 21, wherein the SLDS model describes the dynamics of formants in a frequency-domain representation of speech.

23. The method of Claim 22, wherein the SLDS model is learned from acoustic training data.

24. The method of Claim 1, wherein the SLDS model describes evolution of financial data.

25. A system for tracking a target in a sequence of measurements, comprising:

means for modeling the target with a switching linear dynamic system (SLDS) comprising a plurality of dynamic models;

means for associating each dynamic model with a switching state such that a model is selected when its associated switching state is true;

means for determining, for a given measurement, and for each possible switching state, a set of continuous state estimates;

means for determining a state transition record by determining and recording, for a given measurement and for each possible switching state, an optimal previous switching state, based on the measurement sequence,

wherein the optimal previous switching state optimizes a transition probability based on the set of continuous state estimates;

means for fitting a measurement model of the target to the measurement sequence; and

means for estimating a trajectory responsive to said means for fitting the measurement model, the state transition record and SLDS parameters, said estimated trajectory comprising a sequence of continuous state estimates of the target corresponding to the measurement sequence.

26. A computer program product for determining, given a set of possible switching states and responsive to a sequence of measurements, a corresponding sequence of switching states for a system comprising a plurality of dynamic models, the computer program product comprising a computer usable medium having computer readable code thereon, including program code which:

models the target with a switching linear dynamic system (SLDS) comprising a plurality of dynamic models;

associates each dynamic model with a switching state such that a model is selected when its associated switching state is true;

determines, for a given measurement, and for each possible switching state, a set of continuous state estimates;

determines a state transition record by determining and recording, for a given measurement and for each possible switching state, an optimal previous switching state, based on the measurement sequence, wherein the optimal previous switching state optimizes a transition probability based on the set of continuous state estimates;

fits a measurement model of the target to the measurement sequence; and

estimates a trajectory responsive to the fitted measurement model, the state transition record and SLDS parameters, said estimated trajectory comprising a sequence of continuous state estimates of the target corresponding to the measurement sequence.

27. A computer system comprising:

a processor;

a memory system connected to the processor; and

a computer program, in the memory, which:

models the target with a switching linear dynamic system (SLDS) comprising a plurality of dynamic models;

associates each dynamic model with a switching state such that a model is selected when its associated switching state is true;

determines, for a given measurement, and for each possible switching state, a set of continuous state estimates;

determines a state transition record by determining and recording, for a given measurement and for each possible switching state, an optimal previous switching state, based on the measurement sequence, wherein the optimal previous switching state optimizes a transition probability based on the set of continuous state estimates;

fits a measurement model of the target to the measurement sequence; and

estimates a trajectory responsive to the fitted measurement model, the state transition record and SLDS parameters, said estimated trajectory comprising a sequence of continuous state estimates of the target corresponding to the measurement sequence.

28. A system for tracking a target in a sequence of measurements, comprising:

a Viterbi prediction module which generates, at a given instance, a set of continuous state predictions, based on a set of continuous state predictions for a previous instance, the Viterbi prediction module comprising a switching linear dynamic system (SLDS) which models the target;

the SLDS, which comprises a plurality of linear dynamic system (LDS) models, wherein an LDS model is selected responsive to a switching variable;

a selector which, responsive to the generated continuous state predictions, selects a set of most likely previous switching states corresponding to a set of possible switching states at the given instance, the selector generating a corresponding set of most probable continuous state predictions responsive to measurement data and based on the set of most likely previous switching states; and

an update module which generates a set of posterior continuous state estimates, responsive to the set of most probable continuous state predictions and to measurement data, the posterior continuous state estimates forming a set of continuous state predictions for a next instance.

29. The system of Claim 28, further comprising:

a sample generator which, responsive to the generated continuous state predictions, produces a new set of prediction samples, wherein, the update module is additionally responsive to the sample generator; and

a second selector which selects one posterior continuous estimate from the update module for each switching state.

30. A system for tracking a target in a sequence of measurements, comprising:

a Viterbi prediction module which generates, at a given instance, a set of continuous state predictions, based on a set of continuous state predictions for a previous instance, the Viterbi prediction module comprising a switching linear dynamic system (SLDS) which models the target;

the SLDS, which comprises a plurality of linear dynamic system (LDS) models, wherein an LDS model is selected responsive to a switching variable;

an update module which generates a set of continuous state estimates responsive to the set of continuous state predictions; and

a selector which, responsive to the set of continuous state estimates, selects a set of most likely previous switching states corresponding to a set of possible switching states at the given instance, the selector generating a corresponding set of posterior continuous state estimates, responsive to the set of continuous state predictions and to measurement data and based on the most likely previous switching states, the posterior continuous state estimates forming a set of continuous state predictions for a next instance.

31. The system of Claim 30, further comprising:

a sample generator which, responsive to the generated continuous state predictions, produces a new set of prediction samples; and

a multiple hypothesis tracking (MHT) module, which, responsive to the sample generator, generates a set of estimates using a standard gradient descent algorithm, wherein the selector is additionally responsive to the MHT module.